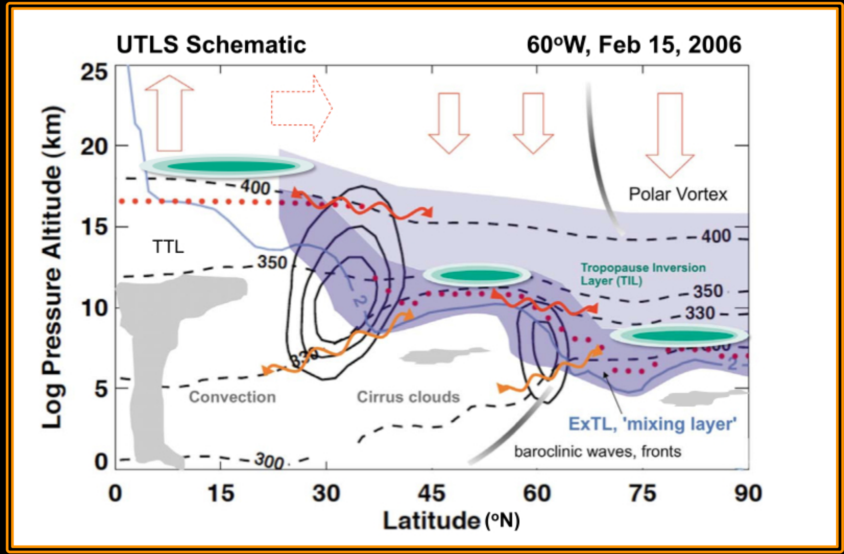
SEAC4RS UTLS Breakout Session



Summary Report

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SEAC4RS Science Team Meeting
April 18, 2014

UTLS Main Goals:

- Gas and aerosol evolution in deep convection with implications for UTLS chemistry.
- Transport times and mechanisms for redistribution of tracers in the UTLS.

Monsoon Season: distribution of water vapor in the UTLS

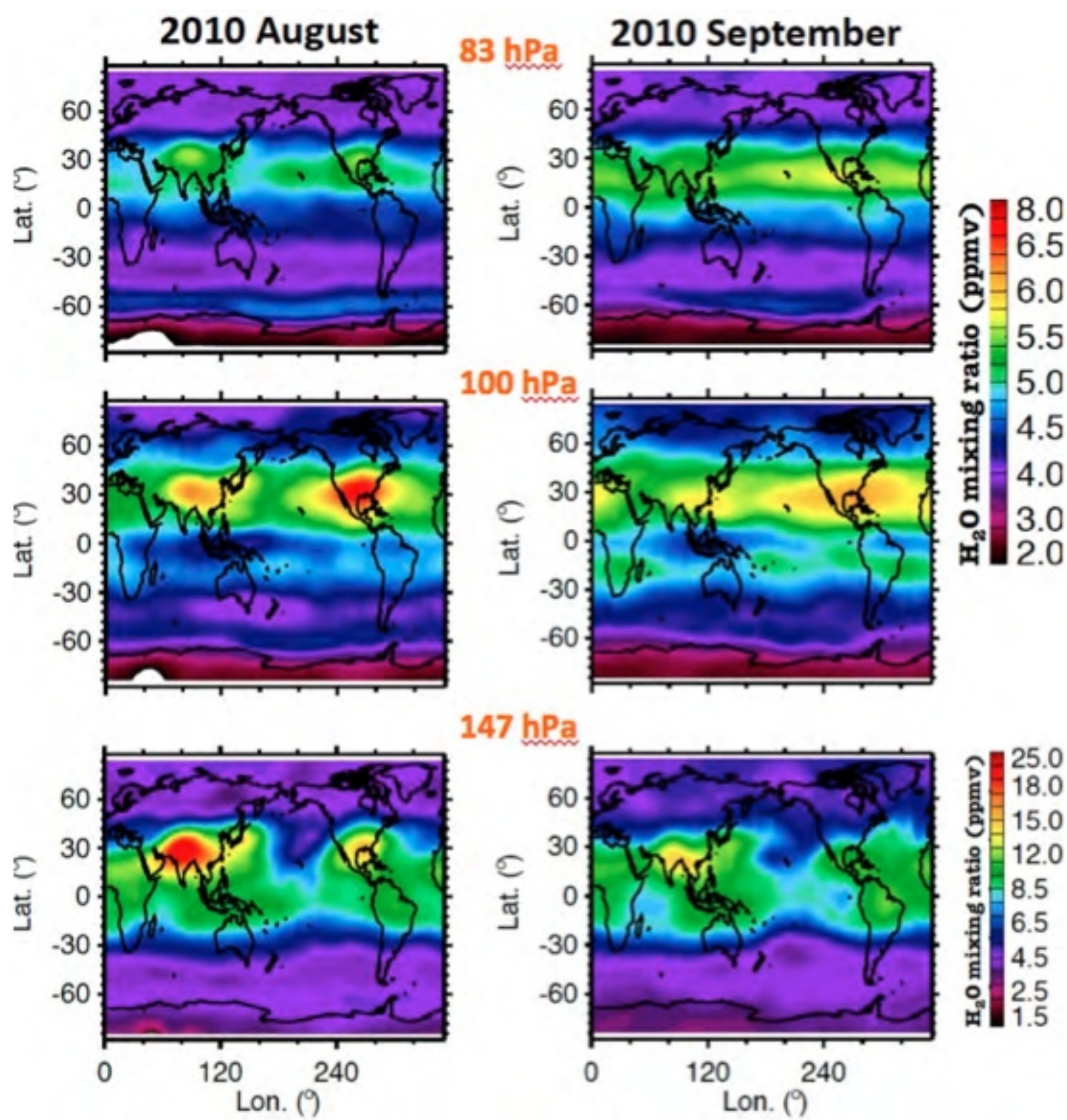

Figure 7. MLS water vapor for August (left) and September (right) at three pressure levels. Note the H2O enhancement at 147 hPa is stronger over the ASM, but at higher levels (100 and 83 hPa), especially in September, the enhancement over the NAM region becomes larger.
(Figure courtesy Tao Wang)

Satellite observations of isotopic water vapor in the UTLS: Importance of Convection over North America

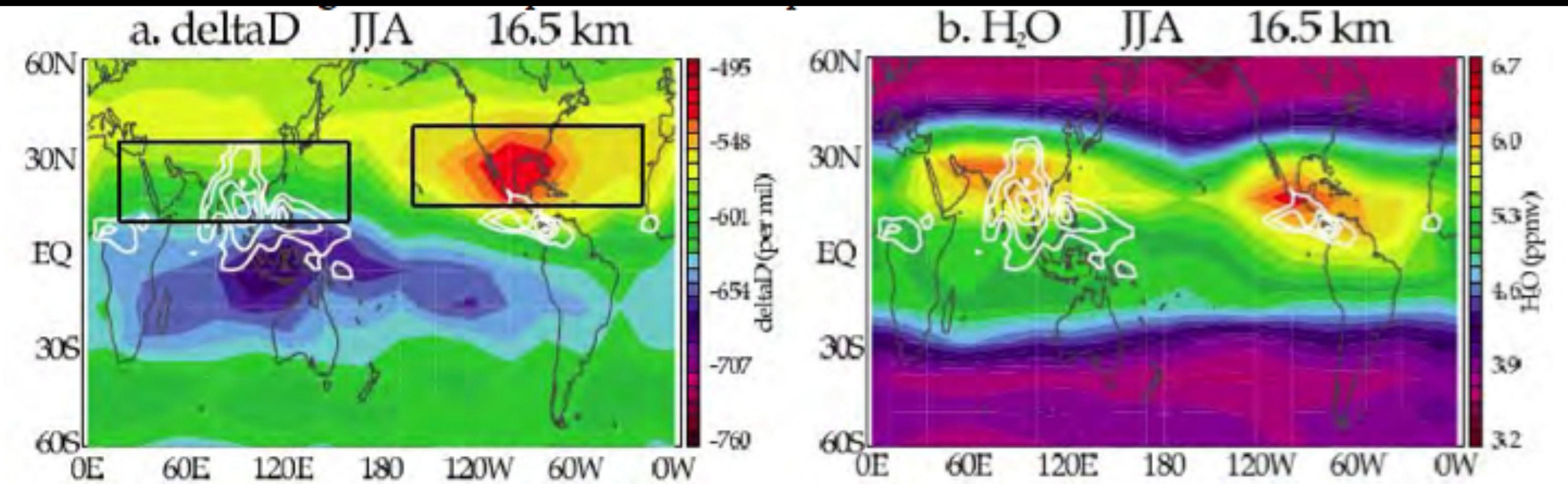

Figure 6. (Fig. 12 of Randel et al., 2012) Maps of (a) **Delta**D and (b) H_2O at 16.5 km during JJA. White contours denote strongest climatological tropical convection, and the black boxes are related to other figures in the paper. Note the isotopic enrichment correlated with high water vapor over the NAM but the lack of a similar signal over the ASM region.

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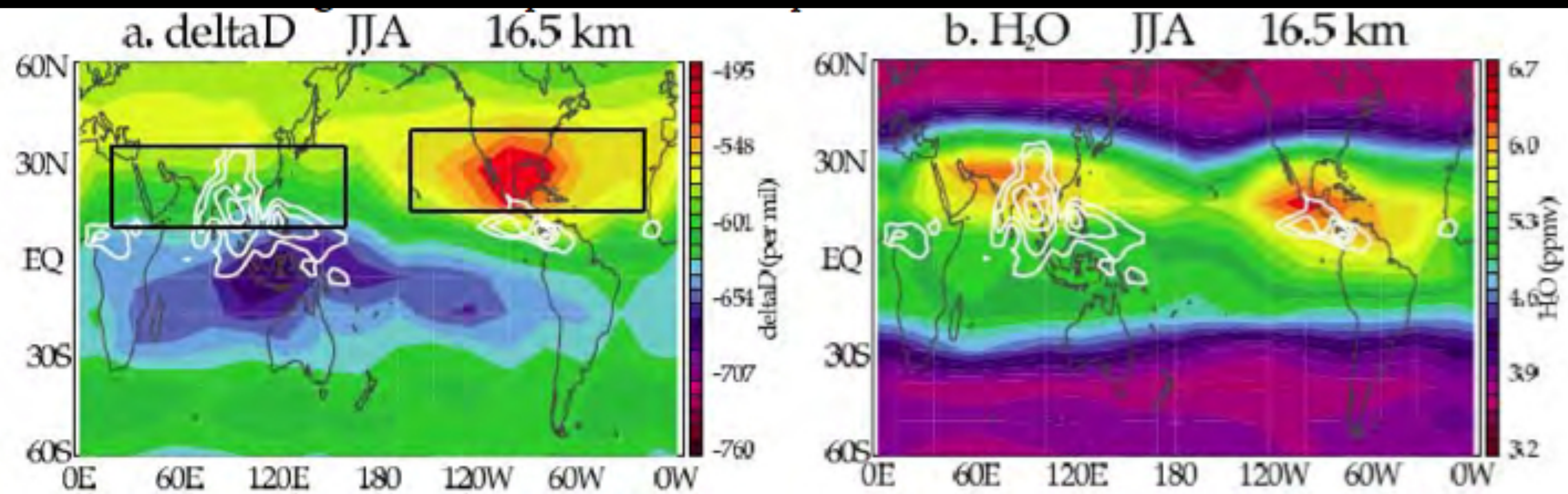

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<u>North American Monsoon (NAM)</u> system: convective transport of water vapor to the UTLS, cirrus cloud distribution and radiation, biomass burning and pollution transport from North Mexico to the South East U.S.

UTLS Challenges:

Large vs Regional vs Local scale processes

Large scale: NAM circulation controlling long-range transport and relocation of injections/outflow from MCSs.

Regional scale: Tropical Cyclone (TC) as a larger-scale, persistent form of deep convection affecting the chemical composition of the UTLS (water, trace gases, etc) by injection or ventilation.

Local scale: deep convection linking various SEAC4RS topics such as distribution of humidity, trace gases, lofting of biomass burning products, aerosols, biogenic emissions, cloud microphysics, and radiation.

UTLS Questions:

- How much of the stratospheric water vapor budget is due to convective penetration?
- What else is pumped into the UTLS besides water?
- What are the mechanisms in this region that push material into the stratosphere? How do they differ from those in the Asian Monsoon?
- How does the monsoon impact cirrus clouds?
- What gases and aerosols make it to the UTLS from a TC? In what quantities?
- Do TCs hydrate or dehydrate the stratosphere?
- How might the relative sparse sampling of satellite data have blurred the structure of deep convective injection into the stratosphere?

Topics Discussed: New "Discoveries"

- Evidence of highest water vapor above 380 K (overworld) to date: interplay between deep convection and monsoon circulation.
- Presence of narrow water vapor structures in the UT, which cannot be observed by satellites.
- Presence of ice clouds above the tropopause, at 390 K, as observed from space by CALIOP.
- Evidence of Tropical Pacific air in the UT extending over the central US: monsoon circulation.
- $CH_3O_2NO_2$, NO_2, and HNO_3 data in the UT allowed for determination of production and rate constants in convective outflow. The new rate constant increases the NO_x lifetime in the UT, impacting O_3 production in this region.
- Larger than expected effective radii were observed below the tropopause by RSP.
- Potential for derivation of solar and IR heating rates during vertical transects of cirrus clouds.

Topics Discussed: "New" Questions

- Strong convective systems that can moisten the overworld: how frequent are they? What are their geographical and seasonal distributions?

- Why don't we see evidence for significant water vapor injections to the stratosphere over Houston: timing? location?

- What is the lifetime of these stratospheric water vapor plumes? How is their dispersion related to the monsoon circulation?

- How does the monsoon circulation affect the isentropic structure in the UTLS?

Action Items:

- Requests for specific trajectory runs from FSU: altitudes, horizontal resolution (e.g., higher resolution for convective studies).
- Convective Influence trajectories along flight tracks – Lenny Pfister
- Submit requests for specific dates of interests (besides Golden Days) if desiring faster access to QA/QC MTP data – Boon Lim

Golden Days:

Date	Remarks
Aug 27	NAM circulation (stirring and redistribution of tracers in the UTLS), Convection, Water vapor injection into the stratosphere
Aug 8	NAM
Aug 16	Large-scale circulation, tropopause structure
Aug 30	Convection

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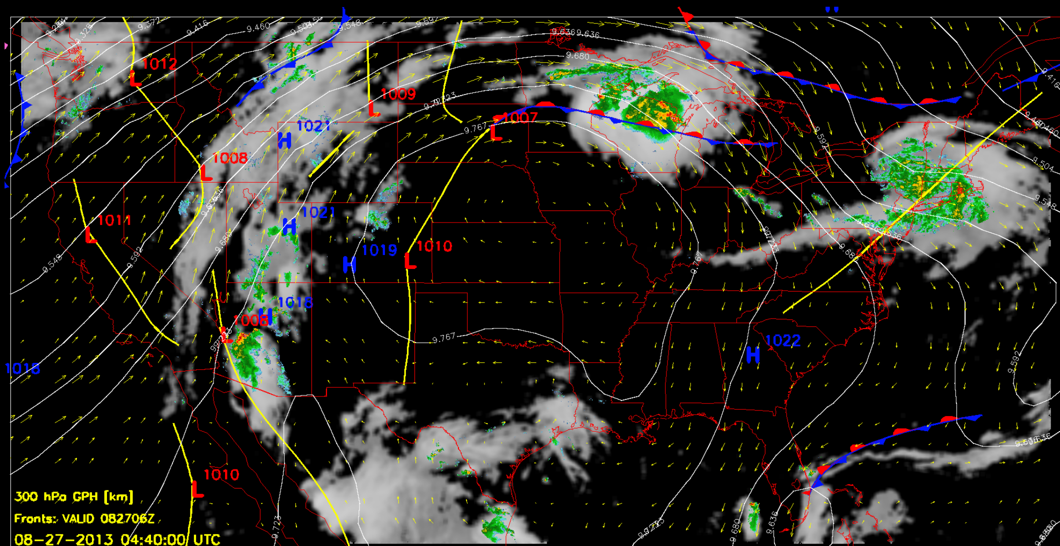
Platinum Days:

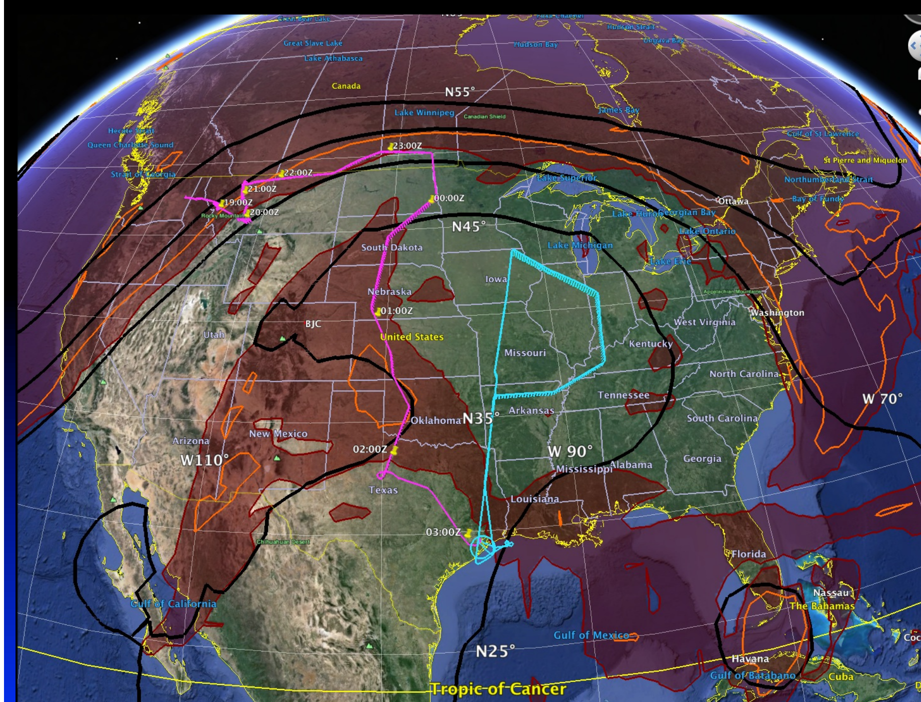
Date	Remarks
???	Intersection of Golden Days for all platforms

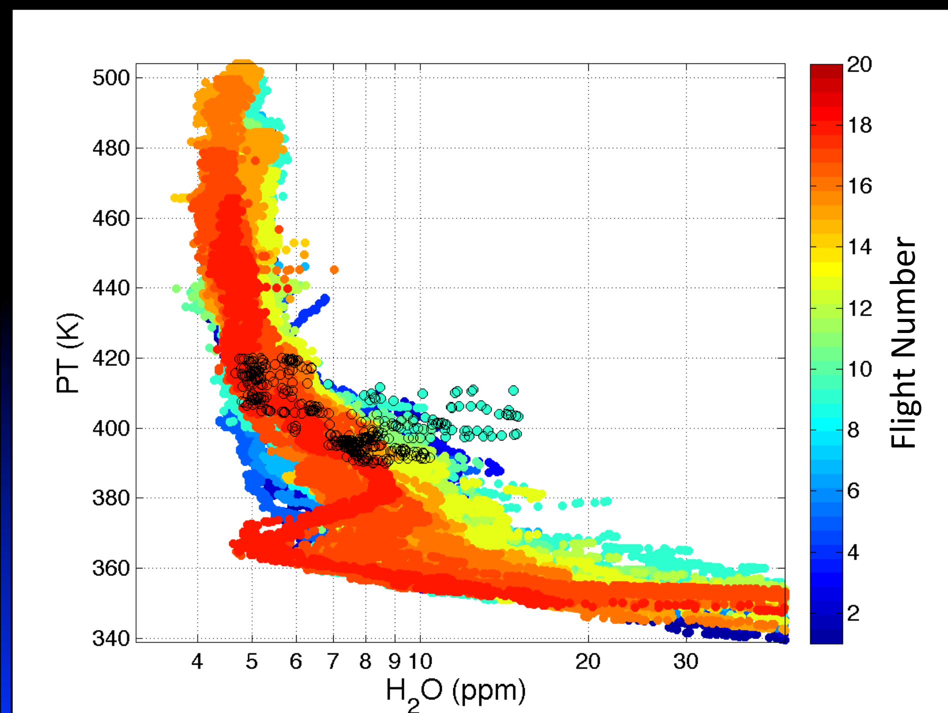


Courtesy of L. Pan

Aug 27, 2013

- Overshooting MCS
- NAM Induced Wave-Breaking
- High Stratospheric Water Vapor





Papers / Topics of research planned:

(1) Impacts of Convective Input and Large-Scale Transport on Lower Stratospheric Water Vapor Concentration over the North American Monsoon – Jensen, Pfister

(2) Analysis of Convectively Sourced Water Vapor in the Stratosphere: A Case Study from SEAC4RS – Smith, Sargent, Atlas, Bedka, Gao, Herman, Jensen, Pittman, Pfister, Read, Selkirk, Wilmouth

(3) Role of Large-Scale NAM Circulation and Tropopause Penetrating MCSs on Water Vapor Transport and Tropopause Structure Perturbation – Pan, Bresch, Homeyer, Honomichl

(4) Role of Large-Scale NAM Circulation in Redistribution of Ozone and Biomass Burning Products – Pan, Bresch, Homeyer, Honomichl

(5) Differences in UTLS Water Vapor and Ozone Between the Tropics and the North American Monsoon: Observations from SEAC4RS and Costa Rica – Selkirk, Herman, Smith, Pfister, Jensen, Vömel, Thompson, Schoeberl, Rosenlof, Troy, Avery

Papers / Topics cont…

(6) Intercomparison of UTLS Water Vapor Measurements from Space-Based, Aircraft, and Balloon Sonde Platforms during SEAC4RS - Herman, Troy, Smith, Sargent, Selkirk, Vömel, Read, Rosenlof, Bui

(7) Summer Stratospheric Water Vapor Budget Using Aircraft and Satellite Data - Rosenlof, Herman

(8) A Climatology of Convective Influence in the UTLS over North America during SEAC4RS: Verification Using Aircraft Data and Comparison with Previous Years - Pfister

(9) Isotopic Composition of Long-Lived Gases in Whole Air Samples - Boering, Atlas, D. Blake, N. Blake

(10) Quantifying Stratospheric Removal Rates and Global Atmospheric Lifetimes for Greenhouse Gases and Ozone Destroying Substances Using Stratospheric Relationships Between CO_2 and Long-Lived Tracers - Wofsy, Pittman, Daube, Newman, Liang, Atlas

Papers / Topics cont…

(11) Determination of Age Spectra and Transport Rates in the TTL Using CO_2 Observations during SEAC4RS - Pittman, Wofsy, Daube, Smith, Atlas, Navarro, Gao, Andrews

(12) Origin of Ozone Enhancements in the Middle Troposphere over St. Louis, Missouri Based on SEACIONS observations - Wilkins, Thompson, Selkirk

(13*) Radiative Heating Rates of TTL Cirrus during SEAC4RS – Bucholtz (co-listed with Clouds)

(14*) NO_x Lifetime in the UTLS: direct measurements of methylperoxinitrate, production rate of HNO_3 in the UT, effect of convection on NO_x in the UT, and comparisons of odd-N observations during SEAC4RS – Cohen, Nault (co-listed with SEUS Chemistry)

(15*) Observations and Origin of the North American Tropopause Aerosol Layer (NATAL) during SEAC4RS - Fairlie, Vernier, Natarajan, Bedka, Hair, Trepte, Avery (co-listed with Aerosols)


Photo by S. Broce